

IO RESULTS FROM GALILEO SSI AND PLANS FOR THE CLOSE FLYBYS. A. McEwen¹, P. Geissler¹, R. Lopes-Gautier², L. Keszthelyi¹, D. Simonelli³, M. Belton⁴, H. Breneman², K. Magee², and the Galileo SSI Team, ¹Lunar and Planetary Lab (University of Arizona, Tucson, AZ 85721, mcewen@lpl.arizona.edu), ²JPL ³Cornell University, ⁴NOAO.

Introduction: Distant monitoring during Galileo's prime mission and early GEM has greatly improved our knowledge of Io's active volcanoes, plumes, and atmosphere. These results point to key questions to address in the close encounters planned for late 1999.

Results: The SSI and NIMS experiments have shown that high-temperature silicate eruptions are ubiquitous [1], and include some very high temperatures suggesting ultramafic compositions [2]. Six-color coverage acquired by SSI in orbits C10 and E14 reveal that the dark lavas associated with hot spots have an absorption band at ~0.9 microns, perhaps due to orthopyroxene [3]. A key question is whether ultramafic eruptions are relatively rare or quite common. If they are rare, and the volcanics have a wide range of silicate compositions, then Io is probably strongly differentiated and compositionally layered [4]. If the very high-temperature eruptions are common and the lavas are richer in orthopyroxene than olivine, then there must be some mechanism to vigorously mix and homogenize the crust and mantle [5]. One way to accomplish such vigorous mixing is to have the entire mantle consist of a convecting magma ocean, but one that must be rich in crystals to satisfy other constraints such as the topographic relief [6]. The high mountains may be evidence for foundering crustal blocks.

In addition to the high-temperature hot spots, SSI has detected diffuse optical emissions from Io during eclipse. The diffuse glows have three components [7]. Blue glows emanate from volcanic plumes, probably due to molecular SO₂. Red emissions are seen around Io's limb, brightest at the pole closest to the plasma torus. A faint green glow is seen against the disk of Io, concentrated on the night side. The red and green glows become fainter with time after entering eclipse, whereas the blue glows become brighter.

Future Observations: Image sequences (SSI and NIMS) planned for orbits C21, I24, and I25 are listed in Table 1. High-resolution images and stereo pairs (up to 10 m/pixel) should reveal whether or not the landforms have morphologies consistent with a range of compositions, or if they are consistent with a more uniform (perhaps ultramafic) composition. High-resolution (up to 200 m/pixel) reflectance spectra and color images should better reveal the compositional

diversity of exposed lavas. Close observations of the active lavas will better constrain the magma temperatures and eruption styles (fountains, channels, lakes, etc.). We expect "bleeding" (from excess electrons) of the SSI images where hot lava is resolved, even at the shortest possible exposure times. We are planning some high-resolution imaging in both clear and green filters to measure very high temperatures and seek better lower limits to the lava temperatures. High-resolution stereo imaging will help illuminate the origin of the tall mountains. In particular, we should be able to determine if the lineations commonly seen in mountains are tectonic or due to layering. Improved constraints on models for the internal structure and tidal heating will result from gravity and magnetic measurements, large-scale topographic mapping, and thermal data to determine heat flow variations.

If the Galileo spacecraft remains healthy, there will be another Io encounter (I27) on Feb 22, 2000. This could be especially important because we will first have the chance to learn from I24 and modify the observation sequences accordingly. At present there is considerable uncertainty about how Jupiter's intense radiation will affect the observations and instrument and spacecraft performance close to Io, in addition to uncertainty about what we'll see on Io at high resolution. Closest approach in I27 is at latitude +20, longitude 203, especially favorable for Zamama.

Improved understanding of the diffuse glows seen in eclipse are expected from (1) an HST Io campaign in conjunction with the Io flybys; (2) additional SSI eclipse images in I24 and (hopefully) after I25; and (3) Cassini imaging observations during the Jupiter flyby in 2001. The Cassini imaging system includes UV bandpasses not available to Galileo, which are especially useful for imaging plumes, both in sunlight and in eclipse.

References: [1] Lopes-Gautier, R., et al. (1999) Icarus, in press. [2] McEwen, A., et al. (1998) Science 281, 87. [3] Geissler, P., et al. (1999) Icarus, in press. [4] Keszthelyi, L., and A. McEwen (1997) Icarus 130, 437. [5] Carr, M., et al. (1998) Icarus 135, 146. [6] Keszthelyi, L., et al. (1999) submitted to Icarus. [7] Geissler, P., et al. (1999) submitted.

Table 1. Galileo SSI and NIMS mosaics of Io planned for orbits C21 (July 2), I24 (Oct. 11), and I25 (Nov. 26) (all in 1999). Most of the SSI mosaic targets will be followed by brief NIMS observations.

Orbit	Target	Lat, Lon	Res. (m/px)	SSI Size	Filters	Science Notes
C21	full disk	0, 135	1250	4x4	GRN	Highest-res map of long. 55-215
	full disk	0, 135	2500	4x4x3	VLT, RED,756	color and NIMS mapping.
	full disk	0, 145	1435	3x4	CLR	regional stereo mapping (with I24)
	plumes	various	3000-15000	1x1	VLT	plume inventory, 21 images
I24	Loki	+12, 209	1000	(NIMS)		south Loki caldera at night
	Pele	-18, 256	20	1x13	CLR	molten lava at night
	Pillan	-11, 243	16	1x13	CLR	lava channels from 1800 K lava
	mountain	+4, 216	14	1x11	CLR	tectonics vs. layers
	Zamama	+18, 173	40	1x13	CLR	fissure flows, plume
	Prometheus	-2, 154	70	1x8x2	CLR, GRN	flows, plume vent, temperatures
	mountain	+4, 216	140	2x1	CLR	regional context
	Tohil Mons	-28, 160	180	2x2	CLR	stereo with I27
	Prometheus	-2, 154	220	1x2x3	VLT,GRN, RED	context, stereo, high-res color (including partial 756, 889, 1MC), extended NIMS mosaic
	Zamama	+24, 190	310	3x6	CLR	regional context (I24 and I27)
	Dorian	-22, 190	340	1x4	CLR	mountain, golf course
	Amirani	+25, 99	390	3x6	CLR	regional mapping
	terminator	-10, 85	440	6x1	CLR	topographic morphologies
	regional	0, 177	14000	(NIMS)		NIMS regional mosaic
	Pillan	-11, 243	25000	(NIMS)		Pillan plume on limb
	Pele	-18, 256	40000	(NIMS)		Pele plume on limb
	full disk	0, 177	1435	3x4	CLR	regional stereo (with C21)
	full disk	1, 243	6600	1x1x6	6 colors	color map and change detection
	full disk	0, 300	15000	1x1x2	CLR, 1MC	eclipse--hot spots
	Creidne	-53, 345	240	(NIMS)		hot spot/caldera at night
	S. Pole	-80, 90	6	1x9	CLR	polar image at very high res.
	plateau	-53, 122	10	1x11	CLR	sapping feature
	Prometheus	-2, 155	26	1x2	CLR	eruption column on bright limb; mostly NIMS
	S. Pole	-80, 90	48	1x6	CLR	regional context
	Emakong	-3, 123	64	1x9	CLR	stereo over thick flows?
	Tupan	-19, 141	80	1x5	CLR	hot spot
	plateau	-53, 122	100	1x6	CLR	regional context
	Shamshu	-9, 65	120	1x6	CLR	oblique topography near terminator
	Tupan	-19, 141	2600	(NIMS)		NIMS mosaic of hot spot
	Emakong	-3, 123	140	1x3	CLR	stereo over thick flows?
	calderas	+50, 125	320	2x4	CLR	3 giant calderas
	Culann	-20, 160	380	2x2x3	VLT,GRN, RED	high-res color, active center
	Emakong	-3, 123	440	1x4	CLR	regional context
	terminator	+20, 68	460	1x10	CLR	topographic morphologies
	Culann	-20, 160	10000	(NIMS)		NIMS mosaic